Committee on Resources
Subcommittee on Energy & Minerals Resources

Witness Statement

Statement of
Timothy S. Collett
Research Geologist
U.S. Geological Survey

Before the
House Committee on Resources
Subcommittee on Energy and Mineral Resources

Hearing on S. 330, the Methane Hydrate Research and Development Act of 1999 and
H.R. 1753, Research Identification, Assessment, Exploration, and Development of Methane Hydrate Resources, and for other purposes
1324 Longworth House Office Building
Washington, D.C.

May 25, 1999

Mr. Chairman and Members:

I am Timothy S. Collett, Research Geologist with the U.S. Geological Survey (USGS). In this testimony I will discuss the USGS assessment of natural gas hydrate resources and examine the technology that would be necessary to safely and economically produce gas hydrates.

I. Summary

The primary objectives of USGS gas hydrate research are to document the geologic parameters that control the occurrence and stability of gas hydrates, to assess the volume of natural gas stored within gas hydrate accumulations, to identify and predict natural sediment destabilization caused by gas hydrate, and to analyze the effects of gas hydrate on drilling safety. The USGS in 1995 made the first systematic assessment of the in-place natural gas hydrate resources of the United States. That study shows that the amount of gas in the hydrate accumulations of the United States greatly exceeds the volume of known conventional domestic gas resources. However, gas hydrates represent both a scientific and technologic frontier and much remains to be learned about their characteristics and possible economic recovery.

II. Gas Hydrate Occurrence and Characterization

Gas hydrates are naturally occurring crystalline substances composed of water and gas, in which a solid water-lattice holds gas molecules in a cage-like structure. Gas hydrates are widespread in permafrost regions and beneath the sea in sediments of the outer continental margins. While methane, propane, and other gases are included in the hydrate structure, methane hydrates appear to be the most common. The amount of methane contained in the world's gas hydrate accumulations is enormous, but estimates of the amounts are speculative and range over three

orders-of-magnitude from about 100,000 to 270,000,000 trillion cubic feet of gas. Despite the enormous range of these estimates, gas hydrates seem to be a much greater resource of natural gas than conventional accumulations.

Even though gas hydrates are known to occur in numerous marine and Arctic settings, little is known about the geologic controls on their distribution. The presence of gas hydrates in offshore continental margins has been inferred mainly from anomalous seismic reflectors that coincide with the base of the gas-hydrate stability zone. This reflector is commonly called a bottom- simulating reflector or BSR. BSRs have been mapped at depths ranging from about 0 to 1,100 m below the sea floor. Gas hydrates have been recovered by scientific drilling along the Atlantic, Gulf of Mexico, and Pacific coasts of the United States, as well as at many international locations.

To date, onshore gas hydrates have been found in Arctic regions of permafrost and in deep lakes such as Lake Baikal in Russia. Gas hydrates associated with permafrost have been documented on the North Slope of Alaska and Canada and in northern Russia. Direct evidence for gas hydrates on the North Slope of Alaska comes from cores and petroleum industry well logs which suggest the presence of numerous gas hydrate layers in the area of the Prudhoe Bay and Kuparuk River oil fields. Combined information from Arctic gas-hydrate studies shows that, in permafrost regions, gas hydrates may exist at subsurface depths ranging from about 130 to 2,000 meters.

The USGS 1995 National Assessment of United States Oil and Gas Resources focused on assessing the undiscovered conventional and unconventional resources of crude oil and natural gas in the United States. This assessment included for the first time a systematic appraisal of the in-place natural gas hydrate resources of the United States, both onshore and offshore. Eleven gas-hydrate plays were identified within four offshore and one onshore gas hydrate provinces. The offshore provinces lie within the U.S. 200 mile Exclusive Economic Zone adjacent to the lower 48 States and Alaska. The only onshore province assessed was the North Slope of Alaska. In-place gas hydrate resources of the United States are estimated to range from 113,000 to 676,000 trillion cubic feet of gas, at the 0.95 and 0.05 probability levels, respectively. Although this range of values shows a high degree of uncertainty, it does indicate the potential for enormous quantities of gas stored as gas hydrates. The mean (expected value) in-place gas hydrate resource for the entire United States is estimated to be 320,000 trillion cubic feet of gas. This assessment does not address the problem of gas hydrate recoverability.

Seismic-acoustic imaging to identify gas hydrate and its effects on sediment stability has been an important part of USGS marine studies since 1990. USGS has also conducted extensive geochemical surveys and established a specialized laboratory facility to study the formation and disassociation of gas hydrate in nature and also under simulated deep-sea conditions. Gas hydrate distribution in Arctic wells and in the deep sea has been studied intensively using geophysical well logs. These efforts have also involved core drilling of gas-hydrate-bearing sediments in cooperation with the Ocean Drilling Program (ODP) of the National Science Foundation, and, most recently a cooperative drilling program onshore in northern Canada.

III. Gas Hydrate Production

Gas recovery from hydrates is hindered because the gas is in a solid form and because hydrates are usually widely dispersed in hostile Arctic and deep marine environments. Proposed methods of gas recovery from hydrates usually deal with disassociating or "melting" in-situ gas hydrates by (1) heating the reservoir beyond the temperature of hydrate formation, (2) decreasing the reservoir pressure below hydrate equilibrium, or (3) injecting an inhibitor, such as methanol, into the reservoir to decrease hydrate stability conditions. Computer models have been developed to evaluate hydrate gas production from hot water and steam injection, and these models suggest that gas can be produced from hydrates at sufficient rates to make gas hydrates a technically recoverable resource. Similarly, the use of gas hydrate inhibitors in the production of gas from hydrates has been shown to be technically feasible, however, the use of large volumes of chemicals comes with a high economic and potential environmental cost. Among the various techniques for production of natural gas from in-situ gas hydrates, the most economically promising method is considered to be depressurization. The Messoyakha gas field in northern Russia is often used as an example of a hydrocarbon accumulation from which gas has been produced from hydrates by simple reservoir depressurization. Moreover the production history of the Messoyakha field possibly demonstrates that gas hydrates are an immediate producible source of natural gas and that production can be started and maintained by "conventional" methods.

IV. Safety and Seafloor Stability

Seafloor stability and safety are two important issues related to gas hydrates. Seafloor stability refers to the susceptibility of the seafloor to collapse and slide as the result of gas hydrate disassociation. The safety issue refers to petroleum drilling and production hazards that may occur in association with gas hydrates in both offshore and onshore environments.

Seafloor Stability

Along most ocean margins the depth to the base of the gas hydrate stability zone becomes shallower as water depth decreases; the base of the stability zone intersects the seafloor at about 500 m. It is possible that both natural and human induced changes can contribute to in-situ gas hydrate destabilization which may convert a hydrate-bearing sediment to a gassy water-rich fluid, triggering seafloor subsidence and catastrophic landslides. Evidence implicating gas hydrates in triggering seafloor landslides has been found along the Atlantic Ocean margin of the United States. The mechanisms controlling gas hydrate induced seafloor subsidence and landslides are not well known, however these processes may release large volumes of methane to the Earth's oceans and atmosphere.

Safety

Throughout the world, oil and gas drilling is moving into regions where safety problems related to gas hydrates may be anticipated. Oil and gas operators have described numerous drilling and production problems attributed to the presence of gas hydrates, including uncontrolled gas releases during drilling, collapse of wellbore casings, and gas leakage to the surface. In the marine environment, gas leakage to the surface around the outside of the wellbore casing may result in local seafloor subsidence and the loss of support for foundations of drilling platforms. These problems are generally caused by the disassociation of gas hydrate due to heating by either warm drilling fluids or from the production of hot hydrocarbons from depth during conventional oil and gas production. The same problems of destabilized gas hydrates by warming and loss of seafloor support may also affect subsea pipelines.

V. Conclusions

Our knowledge of naturally occurring gas hydrates is limited. Nevertheless, a growing body of evidence suggests that (1) a huge volume of natural gas is stored in gas hydrates, (2) production of natural gas from gas hydrates may be technically feasible, (3) gas hydrates hold the potential for natural hazards associated with seafloor stability and release of methane to the oceans and atmosphere, and (4) gas hydrates disturbed during drilling and petroleum production pose a potential safety problem. The USGS welcomes the opportunity to collaborate with domestic and international scientific organizations to further our collective understanding of these important geologic materials.

# # #